Patent Application
Attorney Docket No. 247823

METHOD FOR INSTALLING A FENESTRATION UNIT IN A COMPOSITE PANEL

Filed of the Invention

The present invention relates to a method of installing a fenestration unit in a composite panel using a foam material, and to a composite panel with the fenestration unit installed using a foam material, where the foam material is the primary attachment structure. The present method can be used with prefabricated and on-site constructed composite panels. The present method is also directed to building structures constructed using the composite panels of the present invention.

Background of the Invention

Composite panels are gaining increasing acceptance in building construction in replacing the conventional combination of drywall sheets and rolls of fiberglass insulation. In their basic form, composite panels generally include an insulating core, such as insulating foam, positioned between two outer layers. Additional layers may be included for some applications. The outer layers are generally constructed of a rigid material such as gypsum or cementous composite, oriented strand board, plywood, metal sheeting, or an agricultural board product such as strawboard.

Typically, a fenestration unit is installed in a composite panel by cutting a hole in the panel and building a wood frame around the perimeter of the hole. The fenestration unit is then located in the framed opening, shimmed from the interior of the building, and nailed to the wood frame from the interior of the fenestration unit and/or from the exterior of the building through a plurality of pre-punched holes in nailing fins attached to the fenestration unit. Once the

fenestration unit is secured in place, the installation is completed by locating insulation in the cavity between the wood frame and the fenestration unit.

Brief Summary of the Invention

The present invention relates to a method of installing a fenestration unit in a composite panel using a foam material. The present invention is also directed to a composite panel with the fenestration unit installed using a foam material and to a building structure constructed from the present composite panels. The foam material is preferably the primary attachment structure. The present method can be practiced without the conventional wood or metal frame located in the rough opening formed to receive the fenestration unit.

In one embodiment, a rough opening is created in the composite panel. The rough opening has a perimeter larger than a perimeter of the frame of the fenestration unit. The fenestration unit is then positioned in the rough opening so that a space is formed between the perimeter of the frame of the fenestration unit and the perimeter of the rough opening of the composite panel. A foam material is delivered into the space to fixedly adhere the fenestration unit to the insulating core of the composite panel. The insulating core is typically constructed from a polymeric foam material.

The foam material preferably provides the primary structural attachment between the fenestration unit and the composite panel when the foam material is substantially cured. In another embodiment, the foam material is the sole structural attachment between the fenestration unit and the composite panel. The foam material preferably provides at least 50% of an attachment force that resists separation of the fenestration unit from the composite panel along a direction generally perpendicular to a major surface of the composite panel. The cured foam material preferably provides about 70%, and more preferably about 80%, and most preferably about 95%, of the attachment force.

The foam material is preferably compatible with a material of the insulating core of the composite panel. A low expansion adhesive foam is

preferred. The foam material may be delivered to fixedly adhere to at least one side surface of an outer layer of the composite panel at the rough opening. The foam material is typically delivered around at least a portion of the perimeter of the frame of the fenestration unit. The foam material is preferably delivered around the entire perimeter of the frame of the fenestration unit. In one embodiment, an intermediate adhesion promoting material is applied to at least one of the perimeter of the frame and the insulating core exposed by the rough opening.

In one embodiment, the frame of the fenestration unit includes a fin attached to an outer surface of an outer layer of the composite panel. A sealant material can optionally be located between the fin and the outer surface of the outer layer. Optionally, one or more mechanical fasteners can be used to attach the fin to the outer layer of the composite panel.

In one embodiment, the perimeter of the frame includes recesses adapted to receive the foam material. The peripheral side surface of the fenestration unit includes recesses into which the foam material flows. The recesses increase the resistance to the forces acting on the fenestration unit perpendicular to the outer surface of the composite panel.

The composite panel can be assembled on-site or prefabricated in a remote location. Similarly, the rough opening can be created on-site or at the remote location.

The present invention is also directed to a wall structure comprising a fenestration unit including a frame and a composite panel comprising an insulating core. A rough opening created in the composite panel receives the frame of the fenestration unit. A foam material is deposited between the perimeter of the frame of the fenestration unit and the perimeter of the rough opening of the composite panel to fixedly adhere the fenestration unit to the insulating core of the composite panel.

The present invention is also directed to a composite panel having an insulating core located between outer layers. The composite panel includes a

fenestration unit having a frame. The frame of the fenestration unit is fixedly adhered to the insulating core of the composite panel by a foam material that is deposited between the frame and side surfaces of a rough opening of the composite panel.

Brief Description of the Several Views of the Drawing

Fig. 1a is a front view of a composite panel having a rough opening for receiving a fenestration unit.

Fig. 1b is a horizontal cross-sectional view of the composite panel of Fig. 1a taken along the line 1b – 1b.

Fig. 1c is a vertical cross-sectional view of the composite panel of Fig. 1a taken along the line 1c – 1c

Fig. 2 is a front view of a window unit that is to be installed in the rough opening of the composite panel of Fig. 1a.

Fig. 3 is a fragmentary cross-sectional view of a fenestration unit installed in the rough opening of the composite panel of Fig. 1a using a foam material in accordance with the present invention.

Fig. 4 is a fragmentary cross-sectional view of an alternate fenestration unit installed in the rough opening of the composite panel of Fig. 1a using the foam material in accordance with the present invention.

Fig. 5 is a fragmentary cross-sectional view of another alternate fenestration unit installed in the rough opening of the composite panel of Fig. 1a using the foam material in accordance with the present invention.

Fig. 6 is a fragmentary cross-sectional view of a sill region of a fenestration unit installed in the rough opening of the composite panel of Fig. 1a using the foam material in accordance with the present invention.

Detailed Description of the Invention

The present invention relates to a simplified method for installing a fenestration unit in a composite panel without the typical intermediate frame of

wood or metal in the rough opening. The present invention is also directed to a composite panel with a fenestration unit attached to the insulating core using a foam material. No mechanical fasteners are required. As used herein, "fenestration unit" refers to windows, doors, skylights, shutters, and components thereof, such as window jambs, sills, heads, sash stiles, sash rails, door thresholds, and the like.

Figs. 1a-1c illustrate an exemplary composite panel 10. The composite panel 10 generally includes an insulating core 16 positioned between two outer layers 12 and 14. The outer layers 12 and 14 are generally constructed of a rigid material such as gypsum or cementous composite, oriented strand board, plywood, metal sheeting, or an agricultural board product such as strawboard.

The insulating core 16 is typically a polymeric foam material. In one embodiment, the insulating core is a homogeneous material. Various additives, fillers, and the like can also be added to the insulating core. Various reinforcing structures can optionally be included in the insulating core, such as fiberglass, woven and non-woven polymeric webs, and cellulose-based reinforcing webs. Example of such structures are disclosed in U.S. Pat. Nos. 5,055,242 (Vane); 5,910,458 (Beer); 5,286,553 (Haraguchi); 4,983,453 (Beall); and 6,080,482 (Martin).

The insulating core 16 can be provided as a prefabricated sheet material or it can be extruded at the time the composite panel is assembled. In one embodiment, the composite panel 10 is prefabricated at a remote location, such as a factory. In another embodiment, the composite panel 10 is constructed or assembled generally at the installation site, or in some applications, at the precise location where the composite panel 10 is to be installed. Similarly, the rough opening 20 can be created at the remote location or at the installation site. In one embodiment, the rough opening 20 is created after the composite panel is erected at the construction site. This embodiment provides the greatest flexibility in locating the rough opening 20 in relation to the structure being created.

Examples of composite panels are disclosed in U.S. Patent Nos. 6,627,131 and 6,455,148.

To install the fenestration unit in the composite panel 10, a rough opening 20, having an appropriate size for receiving the fenestration unit, is created in a composite panel 10. In the illustrated embodiment, the rough opening 20 has a height 44 and a width 46 with four side surfaces 22, 24, 26, and 28. A variety of methods can be used to create the rough opening 20 in the composite panel 10, such as for example cutting with a circular or reciprocating saw. In one embodiment, the rough opening 20 is manufactured into the composite panel 10 at the factory where the panel 10 is made. The present method, however, also permits the rough opening 20 to be created in the field, preferably after the composite panel 10 is erected as part of the final structure. Creating the rough opening 20 in the field provides maximum flexibility in locating the fenestration unit in the building structure.

Fig. 2 shows a window unit 30 that is to be installed in the rough opening 20 of the composite panel 10. The window unit 30 has a shape generally corresponding to the rough opening 20. The window unit 30 has a height 48 and a width 49 that are preferably slightly smaller than the height 44 and the width 46 of the rough opening 20, respectively. The window unit 30 includes a window frame 40 and a window pane 42. The window frame 40, which can be constructed of wood, vinyl, aluminum, or a variety of other materials, includes four peripheral side surfaces 32, 34, 36, and 38. The present invention is not limited by the shape or construction of the fenestration unit.

Although the rough opening 20 as shown in Figs. 1a – 1c and the window unit 30 in the illustrated embodiments are rectangular, the present invention is not limited to any particular shape. The rough opening 20 has a perimeter slightly larger than a perimeter of the window frame 40 of the window unit 30, so that the window unit 30 can be received in the rough opening 20 during installation.

The next step is to position the window unit 30 inside the rough opening 20. The side surfaces 22, 24, 26, and 28 of the rough opening 20 are located generally opposite the peripheral side surfaces 32, 34, 36, and 38 of the window unit 30, respectively. Shims or spacers are typically used to temporarily retain the window unit 30 in the desired position within the rough opening 20.

Fig. 3 is a cross-sectional fragmentary view of a composite panel 10 with a fenestration unit installed in the rough opening 20 using a foam material 50 in accordance with the present invention. Space 51 preferably extends around the perimeter of the window frame 40 and the perimeter of the rough opening 20 of the composite panel 10. After the fenestration unit, such as a window unit 30, is positioned inside the rough opening 20, the foam material 50 is delivered into at least a portion of the space 51. The space 51 between the perimeter of the window frame 40 and the perimeter of the rough opening 20 is preferably between about 1/8" and about 1".

The foam material 50 is typically stored under pressure in a suitable container and can be extruded from the container through a tube into the space 51. When the foam material 50 is cured, it functions as an adhesive to retain and seal the window frame 40 to the side surfaces 22, 24, 26, and 28 of the rough opening 20 of the composite panel 10. The cured foam material 50 also functions as a weather resistive barrier to prevent moisture and air from moving through the space 51 between the interior and exterior of the building. Therefore, other insulation materials, such as conventional insulation foam or sealant are typically not required during installation.

In the illustrated embodiment, the interfaces between the side surfaces 22, 24, 26, and 28 of the rough opening 20 and the peripheral side surfaces 32, 34, 36, and 38 of the window frame 40, respectively, are substantially the same. Consequently, only the interface between the peripheral side surface 38 of the window frame 40 and the side surface 28 of the rough opening 20 will be described in detail.

The side surface 28 of the rough opening 20 includes an edge surface 17 of the insulating core 16 and edge surfaces 19 and 21 of the outer layers 12 and 14. In accordance with the present invention, the foam material 50 wets onto and adheres to the edge surface 17 of the insulating core 16 and the peripheral side surface 38 of the window frame. In one embodiment, the foam material also wets onto and adheres to one or both of the edge surfaces 19 and 21 of the outer layers 12 and 14. In another embodiment, the foam material 50 only wets onto and adheres to the edge surface 17 of the insulating core 16. In the illustrated embodiment, the foam material 50 wets onto and adheres to the edge surface 21 of the outer layer 14 and a portion of the edge surface 17 of the insulating core 16, but not the edge surface 19 of the outer layer 12.

The peripheral side surface 38 of the window frame 40 optionally includes recesses 39 into which the foam material 50 flows. The recesses 39 increase the resistance to the forces F acting on the window unit 30 perpendicular to the outer surface 15 of the composite panel 10.

The foam material 50 is preferably applied all the way around the perimeter of the window frame 40. In another embodiment, the foam material 50 is applied around only a portion of the perimeter of the window frame 40. The foam material 50 may fill the entire space 51, or only a portion thereof.

The foam material 50 is preferably compatible with the insulating core 16 of the composite panel 10. In some embodiments, the insulating core 16 exposed in the rough opening 20 and/or the peripheral side surface 38 of the frame 40 on the fenestration unit 30 are treated or coated with an intermediate adhesion promoting material 55 that enhances the compatibly and/or bonding strength with the foam material 50. The intermediate adhesion promoting material 55 is preferably a liquid that can be sprayed or brushed onto the insulating core 16 or the peripheral side surface 38 on the frame 40.

Depending upon the intermediate adhesion promoting material 55 selected, it may be substantially or partially cured before the foam material 50 is applied. In another embodiment, the intermediate adhesion promoting material

55 is part of an activation process. In one embodiment, the intermediate adhesion promoting material 55 is an adhesive that is permitted to at least partially cure before the foam material 50 is applied. As used herein, the phrase "compatible" refers to materials that essentially complete wets and that chemical bonds with the insulating core and/or an intermediate adhesion promoting material applied to the insulating core exposed in the rough opening or applied to the peripheral side surface of the frame of the fenestration unit.

In one embodiment, the foam material 50 is provided in a container with a tube fluidly coupled to the foam material. The foam material 50 is delivered to the space 51 by inserting the tube about 10% to about 90% of the depth of the space 51 and delivering the foam material 50. Delivering a foam material 50 that fills less than the entire space 51 provides the foam material 50 with enough room for expansion during curing. Alternatively, the space 51 is substantially filled with the foam material 50. The foam material 50 is permitted to expand beyond the outer surfaces of the outer layers 12 and 14. After the foam material 50 is substantially cured, the excess foam material 50 is trimmed using a knife or other appropriate tool.

For some applications, it is important not to deposit an excessive amount of the foam material 50 in the space 51. If excessive expanding foam material 50 is delivered into the space 51, pressure may be generated on the window frame 40. If the window frame 40 is deformed (e.g., bowed), the operation of the window unit 30 may be compromised.

The substantially cured foam material 50 preferably provides the primary structural attachment between the window unit 30 and composite panel 10, without the need for an intermediate frame or wood, metal or the like. As used herein, "primary structural attachment" refers to a mechanism that provides at least 50% of an attachment force that resists separation of a fenestration unit from a composite panel along a direction generally perpendicular to a major surface of the composite panel. That is, the shear characteristics of the foam material 50 are substantially greater than the anticipated force F. In the preferred

embodiment, the cured foam material 50 preferably provides about 70%, and more preferably about 80%, and most preferably about 95%, of the attachment force.

In another embodiment, the substantially cured foam material 50 provides the sole structural attachment between the window unit 30 and composite panel 10. As used herein, “sole structural attachment” refers to a mechanism that provides 100% of an attachment force that resists separation of a fenestration unit from a composite panel along a direction generally perpendicular to a major surface of the composite panel, excluding any attachment force provided by fins.

Since the cured foam material 50 provides excellent adhesion and supplies a primary structural attachment, nails, screws and other mechanical fasteners are typically not required for installation, although mechanical fasteners can optionally be used to initially align the fenestration unit in the rough opening and/or to supplement the primary structural attachment. Embodiments using the foam material 50 and the nails and other fasteners in accordance with the present invention will be discussed below.

Table I below lists the expansion information of various commercially available foam materials. The test results demonstrate that Hilti CF511 and Hago Gun Foam produce no bowing of the window frames in jambs and cure more quickly than other foam materials.

TABLE I

Foam material	Expansion information
PUR Fill	Moderate expansion. Easy to clean up. Producing ¼" bow in jambs.
Hilti CF511	Moderate expansion. Easy to clean up. Producing no bow in jambs.
EZ Seal	Very prolonged expansion. Hard to clean up. Producing no bow in jambs.
Hago Gun Foam	Moderate expansion. Easy to clean up. Producing no bow in jambs.
Hilti CF162	Low expansion. Difficult to be filled in the space. Having a very hard substance and little flexibility.

Table II below lists cohesive failure data of various foam materials when tensile loads are applied to the foam materials. The test results demonstrate that Hilti resists higher tensile loads than Dow and Hago.

TABLE II

Foam material	**Tensile stress causing cohesive failure (average of five samples of each material) – Pounds per square inch (PSI)**
Dow	4.6 PSI
Hilti	12 PSI
Hago	6.6 PSI

Table III below lists shear strength data for the foam material. The test results demonstrate that Hilti resist higher load than Dow and Hago.

TABLE III

Foam material	**Shear stress causing cohesive failure (average of four samples of each material) – Pounds per square inch (PSI)**
Dow	5.33 PSI
Hilti	8.76 PSI
Hago	5.96 PSI

Curing the foam material 50 usually takes about 1- 24 hours. Any cured foam material 50 extending out of the space 51 is trimmed. After the foam material 50 is substantially completely cured, the operation of the window unit 30 is checked. If the window unit 30 works properly, trim and sidings can be installed to cover the exterior surface 15 of the outer layer 14.

Fig. 4 is a cross-sectional fragmentary view of an alternate fenestration unit 130 installed in the rough opening 20 of the composite panel 10 using the foam material 50 in accordance with the present invention. After the fenestration unit 130 is positioned in the rough opening 20, the foam material 50 is delivered into the space 151 between the perimeter of the frame 140 and the

perimeter of the rough opening 20 of the composite panel 10. Similar to the embodiment in Fig. 3, the space 151 between the perimeter of the window frame 140 and the perimeter of the rough opening 20 is preferably between about 1/8'' and about 1''.

In the illustrated embodiment, a jamb extension 174 can be added to the interior of the window unit 130. The form material 50 is also delivered into a space between the jamb 174 and the composite panel 10. The foam material 50 wets onto and adheres to a peripheral side surface 138 of the window frame 140, an edge surface 175 of the jamb 174, the edge surface 17 of the insulating core 16, the edge surface 19 of the outer layer 12, and the edge surface 21 of the outer layer 14. As has been described in the previous embodiment, the cured foam material 50 preferably provides the primary structural attachment between the fenestration unit 130 and composite panel 10.

The fenestration unit 130 further includes a fin 168 attached to its frame 140. The fin 168 can be either attached all the way around the perimeter of the frame 140 or attached to a portion of the frame 140. A sealant material 170, such as polyurethane, is preferably located between the fin 168 and the exterior surface 15 of the outer layer 12 of the composite panel 10. The cured sealant material 170 functions as an extra weather resistive barrier in addition to the cured foam material 50. In the illustrated embodiment, one or more nails 172 can optionally be used to fasten the fin 168 to the outer layer 12 of the composite panel 10. The nails 172 provide an extra attachment force that resists separation of the fenestration unit 130 from the composite panel 10 in addition to the primary structural attachment provided by the cured foam material 50.

Fig. 5 illustrates a cross-sectional fragmentary view of yet another embodiment of fenestration unit 230 installed in the rough opening 20 of the composite panel 10 using the foam material 50 in accordance with the present invention. As has been described in the previous embodiments, the foam material 50 is delivered into the space 251 between the perimeter of the frame 240 and the perimeter of the rough opening 20 of the composite panel 10, after the

fenestration unit 230 is positioned inside the rough opening 20. The foam material 50 wets onto and adheres to a peripheral side surface 238 of the window frame 240, the edge surface 21 of the outer layer 14, and a portion of the edge surface 17 of the insulating core 16, but not the edge surface 19 of the outer layer 12. As has been described in the previous embodiments, the cured foam material 50 preferably provides the primary structural attachment between the fenestration unit 230 and composite panel 10.

Similar to the fenestration unit 130 in Fig. 4, the fenestration unit 230 includes a fin 268 attached to its frame 240. A sealant material can be located between the fin 268 and the exterior surface 15 of the outer layer 14 of the composite panel 10. One or more mechanical fasteners 272 can also be used to fasten the fin 268 to the outer layer 12 of the composite panel 10. The mechanical fasteners 272 provide an extra attachment force that resists separation of the fenestration unit 230 from the composite panel 10 in addition to the primary structural attachment provided by the cured foam material 50.

In the illustrated embodiment, a first butyl-based window flashing tape 282 can be applied from the frame 240 over the fin 268 onto the exterior surface 15 of the outer layer 14. A weather resistive wrap 286 can be applied to lap over the fin 268 and the first flashing tape 282. Further, a second butyl-based window flashing tape 284 can be applied to the weather resistive wrap 286 adjacent to the fin 268. Finally, a siding 280 is installed to cover the outer layer 14 of the composite panel 10.

In this embodiment, an L-shaped material 276 is installed to cover a portion of the edge surface 17 of the insulating core 16, the edge surface 19 of the outer layer 12, and the exterior surface 13 of the outer layer 12. The L-shaped material can be attached using mechanical fasteners, adhesives or a variety of other techniques know to those of skill in the art. The L-shaped material 276 is typically constructed of a rigid material such as gypsum plywood, wood, plastic, metal, or composites thereof. Further, a decorative wood trim 278 can optionally

be mounted to the board 276 along a perimeter of the opening surrounded by the board 276.

Fig. 6 is a fragmentary cross-sectional view of a sill region of a fenestration unit 330 installed in the rough opening 20 of the composite panel 10 using the foam material 50 in accordance with the present invention. The fenestration unit 330 includes a sill member 390 having a sloping top wall 392 attached to a frame member 340. After the fenestration unit 330 is positioned inside the rough opening 20, the foam material 50 is delivered into the space 351 between the frame 340 and edge surface of the composite panel 10. The foam material 50 can also optionally be delivered to a space 53 underneath the sloping top wall 392 of the sill member 390. In this embodiment, the foam material 50 wets onto and adheres to an inner surface of the sloping top wall 392, the edge surface 21 of the outer layer 14, and a portion of the edge surface 17 of the insulating core 16, but not the edge surface 19 of the outer layer 12. As has been described in the previous embodiments, the cured foam material 50 preferably provides the primary structural attachment between the fenestration unit 330 and composite panel 10.

Similar to the fenestration unit 130 in Fig. 4, the fenestration unit 330 includes a fin 368 attached to its frame 340. A sealant material can be located between the fin 368 and the exterior surface 15 of the outer layer 14 of the composite panel 10. One or more mechanical fasteners 372 can also be used to fasten the fin 368 to the outer layer 12 of the composite panel 10. The mechanical fasteners 372 provide an extra attachment force that resists separation of the fenestration unit 330 from the composite panel 10 in addition to the primary structural attachment provided by the cured foam material 50. In the illustrated embodiment, a weatherproof tape 382 is optionally applied over the fin 368 onto the exterior surface 15 of the outer layer 14.

Any of the composite panels disclosed herein can be used to construct various structures, such as houses, garages and the like. The composite

panels are attached to each other and integrated into the overall structure using conventional techniques known to those of skill in the art.

All patents and patent applications disclosed herein, including those disclosed in the background of the invention, are hereby incorporated by reference. Although the present invention has been described with reference to preferred embodiments, workers skilled in the art will recognize that changes may be made in form and detail without departing from the spirit and scope of the invention. In addition, the invention is not to be taken as limited to all of the details thereof as modifications and variations thereof may be made without departing from the spirit or scope of the invention. For example and although the target elements of uniformly thick layers is disclosed, differing thickness might also be incorporated into the target assembly.